FORM PTO-1390
(REV. 5-93)

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER
10191/1782

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)
09/856019

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATES CLAIMED
PCT/DE99/03111	(28.09 99) 28 September 1999	(16.11 98) 16 November 1998

TITLE OF INVENTION
DEVICE FOR DETECTING THE MANNER IN WHICH A VEHICLE SEAT IS OCCUPIED

APPLICANT(S) FOR DO/EO/US
POECHMUELLER, Werner

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (unsigned)
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included
13. ☒ A **FIRST** preliminary amendment.
    ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☒ A substitute specification and marked up version of substitute specification..
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: Copies of International Search Report, Preliminary Examination Report and Form PCT/RO/101.

EXPRESS NO. EL302704133

U.S. APPLICATION NO. (if known, see 37 C.F.R. 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/856019	PCT/DE99/03111	10191/1782

17. ☒ The following fees are submitted:

	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)):		
Search Report has been prepared by the EPO or JPO $860.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) $670.00		
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) $750.00		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO $970.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $96.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$860	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

Claims	Number Filed	Number Extra	Rate		
Total Claims	8 - 20 =	0	X $18.00	$	
Independent Claims	1 - 3 =	0	X $78.00	$	
Multiple dependent claim(s) (if applicable)			+ $260.00	$	
TOTAL OF ABOVE CALCULATIONS =				$860	
Reduction by ½ for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$860	
Processing fee of $130.00 for furnishing the English translation later the ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$860	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +				$	
TOTAL FEES ENCLOSED =				$860	
				Amount to be: refunded	$
				charged	$

a. ☐ A check in the amount of $_____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 11-0600 in the amount of **$860.00** to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 11-0600. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Kenyon & Kenyon
One Broadway
New York, New York 10004

By: Reg No 35,486

SIGNATURE

Richard L. Mayer, Reg. No. 22,490
NAME

5/16/01
DATE

26646
PATENT TRADEMARK OFFICE

[10191/1782]

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s)	:	Werner POECHMUELLER
Serial No.	:	To Be Assigned
Filed	:	Herewith
For	:	DEVICE FOR DETECTING THE MANNER IN WHICH A VEHICLE SEAT IS OCCUPIED
Examiner	:	To Be Assigned
Art Unit	:	To Be Assigned

Assistant Commissioner for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT AND

37 C.F.R. § 1.125 SUBSTITUTE SPECIFICATION STATEMENT

SIR:

Please amend the above-identified application before examination, as set forth below.

IN THE SPECIFICATION AND ABSTRACT:

In accordance with 37 C.F.R. § 1.121(b)(3), a Substitute Specification (including the Abstract, but without claims) accompanies this response. It is respectfully requested that the Substitute Specification (including Abstract) be entered to replace the Specification of record.

IN THE CLAIMS:

Please cancel original claims 1-7 and please cancel substitute claims 1-7, without prejudice.

Please add the following new claims:

8. (New) A device for detecting a manner in which a vehicle seat is occupied, comprising:

a stereoscopic image recording device including at least one optical sensor recording a scene at the vehicle seat, the image recording device deriving, from the scene, a three-dimensional map partitioned into a plurality of zones, indicating for each of the zones a distance from a reference point, the at least one optical sensor having a nonlinear transducer characteristic curve, describing a correlation between an incident light intensity and an electrical output signal of the at least one optical sensor, a steepness of the characteristic curve decreasing with increasing light intensity.

9. (New) The device according to claim 8, wherein the characteristic curve has a logarithmic shape.

10. (New) The device according to claim 8, wherein the at least one optical sensor includes two optical sensors situated at a predefined distance from each other, the at least two optical sensors simultaneously recording the scene at the vehicle seat.

11. (New) The device according to claim 8, further comprising a stereo-optical instrument taking two images of the vehicle seat, offset by a defined distance from each other, on a single optical sensor.

12. (New) The device according to claim 8, further comprising a light source for illuminating the scene at the vehicle seat, the light source shining light synchronously with an activation of the image recording device.

13. (New) The device according to claim 12, wherein the light source shines light in the infrared range.

14. (New) The device according to claim 8, further comprising an infrared band-pass filter situated in front of the at least one optical sensor.

15. (New) The device according to claim 13, further comprising an infrared band-pass filter situated in front of the at least one optical sensor.

REMARKS

This Preliminary Amendment cancels without prejudice original claims 1-7 and substitute claims 1-7 in the underlying PCT Application No. PCT/DE99/03111, and adds new claims 8-15. The new claims conform the claims to U.S. Patent and Trademark Office rules and do not add new matter to the application.

In accordance with 37 C.F.R. § 1.121(b)(3), the Substitute Specification (including the Abstract, but without the claims) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to U.S. Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. § 1.121(b)(3)(iii) and § 1.125(b)(2), a Marked Up Version Of The Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) is respectfully requested.

The underlying PCT Application No. PCT/DE99/03111 includes an International Search Report, dated March 14, 2000. The Search Report includes a list of documents that were uncovered in the underlying PCT Application. A copy of the Search Report accompanies this Preliminary Amendment.

Applicant asserts that the present invention is new, non-obvious, and useful. Prompt consideration and allowance of the claims are respectfully requested.

Respectfully Submitted,

KENYON & KENYON

Dated: 5/16/01

By: By Telephone

Richard L. Mayer
Reg. No. 22,490

One Broadway
New York, NY 10004
(212) 425-7200

362225

[10191/1782]

DEVICE FOR DETECTING THE MANNER IN WHICH A VEHICLE SEAT IS OCCUPIED

Field Of The Invention

The present invention relates to a device for detecting the manner in which a vehicle seat is occupied, a stereoscopic image recording device having at least one optical sensor recording the scene at the vehicle seat, and deriving from that a three-dimensional map partitioned into a plurality of zones, giving, for each zone, the distance from a reference point.

Background Information

Investigations, e.g. by NHTBA (National Highway Traffic Safety Administration) have shown that children, sitting in the passenger seat of the vehicle, in particular in a backward aligned child's seat, have suffered deadly injuries from the realease of an airbag. A releasing airbag, in general, poses a danger of injury to a person in the vehicle seat, when this person, for reasons of sitting position, body size or leaning forward in the direction of the airbag prior to the occurrence of the accident, is at too short a distance from the airbag. There are occupational situations, especially in the case of the passenger seat, in which the airbag should better not be released. Among such occupational situations belongs, for example, the occupation of the vehicle seat by a child's seat, or laying down articles not needing protection, or a much too small clearance between the passenger and the airbag. Intelligent airbag systems for use in the future should be in a position to match the amount of airbag inflation to the size and the sitting position of the current vehicle occupant.

That certainly shows that it is unavoidable, for the control of the airbag's release, to detect the manner of occupation of the vehicle seat, in order to avoid unnecessary release of the

airbag, or endangering the person in the vehicle seat. There already are different kinds of devices for recognizing the manner of occupation of the seat. A device for detecting the manner of occupation of a vehicle seat, described in the introduction, which has a stereoscopic image recording system, is described in German Patent No. 197 41 393. With the use of such a stereoscopic image recording device, distances of the vehicle seat area, divided by zones, form a reference point which can be ascertained with the aid of the known triangulation method. A so-called three-dimensional map containing a plurality of zones is generated thereby, from which can be read with great accuracy whether and how the vehicle seat is occupied, or which sitting position a vehicle passenger sitting on it has assumed for the moment. This information can now be used for controlling restraint systems such as airbags or belt tighteners.

The accuracy of a three-dimensional map created by a image recording device depends strongly on the image-taking quality of the optical sensors. The scenic lighting conditions have a strong influence on the image quality. In motor vehicles, especially, very extreme lighting conditions come about. This is true for one, because the motor vehicle is in an open environment. That means that the most varied lighting conditions are possible - day, night, low-in-the-sky and blinding sun, blinding headlights of other vehicles, etc. Besides that, a vehicle can move very fast, so that lighting conditions can change a great deal in a short space of time (e.g. while driving into a shaded region, while leaving a tunnel and the like. Linear optical sensors, as are used for the recognition of seat occupation according to German Patent No. 197 41 393, show a very great dependence on changes in brightness of the recorded scene. In order to reduce as far as possible the great brightness dynamics occurring in the vehicle, a strong light source for lighting the scene being looked at is required, according to German Patent No. 197 41

393.

The present invention now is based on the object of presenting a device, of the kind mentioned at the beginning, which, in spite of the great brightness dynamic, and even without using a very strong light source, can reliably identify the kind of occupation of a vehicle seat.

Summary Of The Invention

The object mentioned is attained, in that the at least one optical sensor, which is contained in the stereoscopic image recording device, has a nonlinear transformer characteristic describing the correlation between the entering light intensity and its electrical output, whose characteristic curve steepness decreases with increasing light intensity. Such a nonlinear optical sensor is capable of recording the scene at the vehicle seat with high resolution, even during great brightness dynamics, only a low-cost light source being required for illuminating the scene.

Optical sensors whose transducer characteristics have a logarithmic pattern are particularly suitable for recording scenes with very great brightness dynamics.

For the realization of a stereoscopic image recording device, either optical sensors arranged at defined distances from one another can be provided, or a stereooptical instrument, which images two images of the vehicle seat, offset to each other by a defined amount, on a single optical sensor.

Preferably, a light source is available for illuminating the scene of the vehicle seat, which shines synchronously with the activation of the image recording device. It is expedient if the light source shines a light in the infrared region, invisible to the vehicle passengers. In order to keep disturbing scattered light away from the image recording

device, an infrared band-pass filter is preferably arranged immediately in front of the at least one optical sensor, whose range lies within the light-sensitive range of the optical sensor.

Brief Description Of The Drawing

Figure 1 shows a vehicle with a stereoscopic image recording device.

Figure 2 shows a stereoscopic image recording device having two optical sensors.

Figure 3 shows a stereoscopic image recording device having one optical sensor.

Figure 4 shows a nonlinear transducer characteristic curve of an optical sensor.

Figure 5a shows a three-dimensional map of an unoccupied vehicle seat.

Figure 5b shows a three-dimensional map of an occupied vehicle seat.

Detailed Description

Figure 1 shows schematically a vehicle 1 having a vehicle seat 2, for example, a passenger seat. In the area of vehicle 1's roof, a stereoscopic image recording device is positioned, containing two optical sensors 3 and 4, by which the scene at vehicle seat 2 is recorded. The two optical sensors 3 and 4 record two image segments, offset by a defined distance from each other, indicated in the drawing by broken borderlines. The two image segments form an overlapping area 5 (the hatched area) which exactly encompasses the space of the vehicle seat in which a person or another object can stay. As can be seen in German Patent No. 197 41 393, with such a stereoscopic

image recording device one can ascertain the distance of image segments from a reference point (e.g. the location of the optical sensors or the location of the airbag cover), with the aid of known triangulation methods.

The stereoscopic image recording device illustrated in Figure 2, as shown also in Figure 1, includes two optical sensors 3 and 4, arranged at a defined distance from each other. Lenses 6 and 7 are arranged in front of the optical snesors 3 and 4, so as to form suitable rays. The output signals of the two optical sensors 3 and 4 are conducted to an image processor 8, which derives a three-dimensional map of the vehicle seat from the images recorded, as will be explained in more detail in connection with Figures 5a and 5b, and communicates the seat occupation ascertained from this, via an output signal 9, to a control device, not shown, for restraint devices. The control device can then control the release of one or more airbags and belt tighteners, depending on the information 9.

A light source 10 is provided to illuminate the scene at the vehicle seat. The light source 10 has, for example, a plurality of light diodes 11 emitting infrared light. The image processor 8 switches on the light source 10 synchronously with the image sensors 3 and 4. Thus, the light source 10 is only active when the optical sensors 3 and 4 are switched on for taking an image. In that way, the average emitted optical power can be held to as low as possible, at recording time the scene being illuminated with sufficient brightness. Recording of spurious radiation by optical sensors 3 and 4 can be avoided by placing an infrared band-pass filter, adjusted to the spectral range emitted by the light source 10, in front of sensors 3 and 4.

As shown in Figure 3, in place of two optical sensors, one single optical sensor 13 can be put in place, on which, via a stereooptical instrument 2, images are imaged which are offset

to each other by a defined amount. The stereooptical instrument has two optical ray paths, having rerouting elements 15, 16 and 17 arranged within them, lenses 18 and 19 being arranged at the input to the stereooptical instrument. The rays taken up by the optical paths, offset to each other, of the stereooptical instrument, strike adjoining, separate sensor zones in the optical sensor 13. That means, a sensor here records two images, which are evaluated in the image processor 8 exactly the same as in the exemplary embodiment according to Figure 2.

The optical sensors 3, 4, 13 have a transducer characteristic curve shown in Figure 4, which describes the correlation between incident light intensity L and the electrical output signal (voltage U or current I). The transducer characteristic curve has a nonlinear shape such that the characteristic curve steepness decreases with increasing light intensity. An optical sensor with such a nonlinear characteristic curve is known from German Patent No. 42 09 536. Because of the nonlinear shape of the transducer characteristic curve, the optical sensors 3, 4, 13 convert light signals with great brightness dynamics into a reduced output signal dynamic. Because of that, the contrast of the optical sensors 3, 4, 13 becomes constant, almost independently of the illumination intensity. In the case of such optical sensors, which have a nonlinear, preferably logarithmic transducer characteristic curve, high resolution recording of the scene at the vehicle seat is possible, even at great light intensity fluctuations.

In the upper part of Figure 5a an image segment 20 of vehicle seat 2 is shown, taken by the image recording device. Below that, a three-dimensional map 21, derived by image processor 8 from the two recorded images, is shown. On this map 21, the entire image segment is partitioned into a plurality of zones. The zones are assigned numbers which give the distance of the respective image zone from a reference point. The larger the

numerical value, the greater is the distance of the respective image zone from the reference point. Zone 22, for example, has a distance value of 76. Some zones are not furnished with a number because the image processor was not able to ascertain an unequivocal distance value for them.

The upper part of Figure 5b shows an image segment 23 of the vehicle seat 2 occupied by a person 24. Below that is the three-dimensional map 25 ascertained by image processor 8. A comparison of the three-dimensional map 21 of the unoccupied vehicle seat with the three-dimensional map 25 of the occupied vehicle seat makes it clear that, using the described image recording device, unequivocal information about the sitting position of a person occupying the vehicle seat can be obtained. The three-dimensional map also gives unequivocal information on whether the seat is occupied in the first place, whether there is a child's seat on it, whether there is a small or a large person on the vehicle seat, or whether the vehicle seat is not occupied at all by a child's seat or a person, but rather, another article has been put down on it.

Abstract Of The Disclosure

The device includes a stereoscopic image recording device having at least one optical sensor which records the scene at the vehicle seat and derives from that a three-dimensional map, partitioned into a plurality of zones, giving for each zone its distance from a reference point. In order to make possible reliable recognition of the manner of the seat's occupation, even during great fluctuations of light intensity, the at least one optical sensor has a nonlinear characteristic curve, describing the correlation between the incident light intensity and its electrical output signal, whose characteristic curve steepness decreases with increasing light intensity.

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DEVICE FOR DETECTING THE MANNER IN WHICH A VEHICLE SEAT IS OCCUPIED

[Background Information] Field Of The Invention

The present invention relates to a device for detecting the manner in which a vehicle seat is occupied, a stereoscopic image recording device having at least one optical sensor recording the scene at the vehicle seat, and deriving from that a three-dimensional map partitioned into a plurality of zones, giving, for each zone, the distance from a reference point.

Background Information

Investigations, e.g. by NHTBA (National Highway Traffic Safety Administration) have shown that children, sitting in the passenger seat of the vehicle, in particular in a backward aligned child's seat, have suffered deadly injuries from the realease of an airbag. A releasing airbag, in general, poses a danger of injury to a person in the vehicle seat, when this person, for reasons of sitting position, body size or leaning forward in the direction of the airbag prior to the occurrence of the accident, is at too short a distance from the airbag. There are occupational situations, especially in the case of the passenger seat, in which the airbag should better not be released. Among such occupational situations belongs, for example, the occupation of the vehicle seat by a child's seat, or laying down articles not needing protection, or a much too small clearance between the passenger and the airbag. Intelligent airbag systems for use in the future should be in a position to match the amount of airbag inflation to the size and the sitting position of the current vehicle occupant.

That certainly shows that it is unavoidable, for the control of the airbag's release, to detect the manner of occupation of the vehicle seat, in order to avoid unnecessary release of the

airbag, or endangering the person in the vehicle seat. There already are different kinds of devices for recognizing the manner of occupation of the seat. A device for detecting the manner of occupation of a vehicle seat, described in the introduction, which has a stereoscopic image recording system, is [known from] described in German Patent No. 197 41 393 [A1]. With the use of such a stereoscopic image recording device, distances of the vehicle seat area, divided by zones, form a reference point which can be ascertained with the aid of the known triangulation method. A so-called three-dimensional map containing a plurality of zones is generated thereby, from which can be read with great accuracy whether and how the vehicle seat is occupied, or which sitting position a vehicle passenger sitting on it has assumed for the moment. This information can now be used for controlling restraint systems such as airbags or belt tighteners.

The accuracy of a three-dimensional map created by a image recording device depends strongly on the image-taking quality of the optical sensors. The scenic lighting conditions have a strong influence on the image quality. In motor vehicles, especially, very extreme lighting conditions come about. This is true for one, because the motor vehicle is in an open environment. That means that the most varied lighting conditions are possible - day, night, low-in-the-sky and blinding sun, blinding headlights of other vehicles, etc. Besides that, a vehicle can move very fast, so that lighting conditions can change a great deal in a short space of time (e.g. while driving into a shaded region, while leaving a tunnel and the like. Linear optical sensors, as are used for the recognition of seat occupation according to German Patent No. 197 41 393 [A1], show a very great dependence on changes in brightness of the recorded scene. In order to reduce as far as possible the great brightness dynamics occurring in the vehicle, a strong light source for lighting the scene being looked at is required, according to German Patent No. 197 41

393 [A1].

The present invention now is based on the object of presenting a device, of the kind mentioned at the beginning, which, in spite of the great brightness [dynamice] dynamic, and even without using a very strong light source, can reliably identify the kind of occupation of a vehicle seat.

Summary [of the] Of The Invention

The object mentioned is attained [by the features of Claim 1], in that the at least one optical sensor, which is contained in the stereoscopic image recording device, has a nonlinear transformer characteristic describing the correlation between the entering light intensity and its electrical output, whose characteristic curve steepness decreases with increasing light intensity. Such a nonlinear optical sensor is capable of recording the scene at the vehicle seat with high resolution, even during great brightness dynamics, only a low-cost light source being required for illuminating the scene.

[Advantageous further developments of the present invention come to light from the dependent claims.]

Optical sensors whose transducer characteristics have a logarithmic pattern are particularly suitable for recording scenes with very great brightness dynamics.

For the realization of a stereoscopic image recording device, either optical sensors arranged at defined distances from one another can be provided, or a stereooptical instrument, which images two images of the vehicle seat, offset to each other by a defined amount, on a single optical sensor.

Preferably, a light source is available for illuminating the scene of the vehicle seat, which shines synchronously with the activation of the image recording device. It is expedient if

the light source shines a light in the infrared region, invisible to the vehicle passengers. In order to keep disturbing scattered light away from the image recording device, an infrared band-pass filter is preferably arranged immediately in front of the at least one optical sensor, whose range lies within the light-sensitive range of the optical sensor.

Brief Description [of the Drawing] Of The Drawing

[The present invention is explained in detail below, using several exemplary embodiments represented in the drawing. The figures show:

Figure 1]Figure 1 shows a vehicle with a stereoscopic image recording device[,].

Figure 2 shows a stereoscopic image recording device having two optical sensors[,].

Figure 3 shows a stereoscopic image recording device having one optical sensor[,].

Figure 4 shows a nonlinear transducer characteristic curve of an optical sensor[,].

Figure 5a shows a three-dimensional map of an unoccupied vehicle seat [and].

Figure 5b shows a three-dimensional map of an occupied vehicle seat.

Detailed Description [of the Exemplary Embodiments]

Figure 1 shows schematically a vehicle 1 having a vehicle seat 2, for example, a passenger seat. In the area of vehicle 1's roof, a stereoscopic image recording device is positioned, containing two optical sensors 3 and 4, by which the scene at

vehicle seat 2 is recorded. The two optical sensors 3 and 4 record two image segments, offset by a defined distance from each other, indicated in the drawing by broken borderlines. The two image segments form an overlapping area 5 (the hatched area) which exactly encompasses the space of the vehicle seat in which a person or another object can stay. As can be seen in German Patent No. 197 41 393 [A1], with such a stereoscopic image recording device one can ascertain the distance of image segments from a reference point (e.g. the location of the optical sensors or the location of the airbag cover), with the aid of known triangulation methods.

The stereoscopic image recording device illustrated in Figure 2, as shown also in Figure 1, includes two optical sensors 3 and 4, arranged at a defined distance from each other. Lenses 6 and 7 are arranged in front of the optical snesors 3 and 4, so as to form suitable rays. The output signals of the two optical sensors 3 and 4 are conducted to an image processor 8, which derives a three-dimensional map of the vehicle seat from the images recorded, as will be explained in more detail in connection with Figures 5a and 5b, and communicates the seat occupation ascertained from this, via an output signal 9, to a control device, not shown, for restraint devices. The control device can then control the release of one or more airbags and belt tighteners, depending on the information 9.

A light source 10 is provided to illuminate the scene at the vehicle seat. The light source 10 has, for example, a plurality of light diodes 11 emitting infrared light. The image processor 8 switches on the light source 10 synchronously with the image sensors 3 and 4. Thus, the light source 10 is only active when the optical sensors 3 and 4 are switched on for taking an image. In that way, the average emitted optical power can be held to as low as possible, at recording time the scene being illuminated with sufficient brightness. Recording of spurious radiation by optical sensors

3 and 4 can be avoided by placing an infrared band-pass filter, adjusted to the spectral range emitted by the light source 10, in front of sensors 3 and 4.

As shown in Figure 3, in place of two optical sensors, one single optical sensor 13 can be put in place, on which, via a stereooptical instrument 2, images are imaged which are offset to each other by a defined amount. The stereooptical instrument has two optical ray paths, having rerouting elements 15, 16 and 17 arranged within them, lenses 18 and 19 being arranged at the input to the stereooptical instrument. The rays taken up by the optical paths, offset to each other, of the stereooptical instrument, strike adjoining, separate sensor zones in the optical sensor 13. That means, a sensor here records two images, which are evaluated in the image processor 8 exactly the same as in the exemplary embodiment according to Figure 2.

The optical sensors 3, 4, 13 have a transducer characteristic curve shown in Figure 4, which describes the correlation between incident light intensity L and the electrical output signal (voltage U or current I). The transducer characteristic curve has a nonlinear shape such that the characteristic curve steepness decreases with increasing light intensity. An optical sensor with such a nonlinear characteristic curve is known from German Patent [(C)] No. 42 09 536 [C2]. Because of the nonlinear shape of the transducer characteristic curve, the optical sensors 3, 4, 13 convert light signals with great brightness dynamics into a reduced output signal dynamic. Because of that, the contrast of the optical sensors 3, 4, 13 becomes constant, almost independently of the illumination intensity. In the case of such optical sensors, which have a nonlinear, preferably logarithmic transducer characteristic curve, high resolution recording of the scene at the vehicle seat is possible, even at great light intensity fluctuations.

In the upper part of Figure 5a an image segment 20 of vehicle seat 2 is shown, taken by the image recording device. Below that, a three-dimensional map 21, derived by image processor 8 from the two recorded images, is shown. On this map 21, the entire image segment is partitioned into a plurality of zones. The zones are assigned numbers which give the distance of the respective image zone from a reference point. The larger the numerical value, the greater is the distance of the respective image zone from the reference point. Zone 22, for example, has a distance value of 76. Some zones are not furnished with a number because the image processor was not able to ascertain an unequivocal distance value for them.

The upper part of Figure 5b shows an image segment 23 of the vehicle seat 2 occupied by a person 24. Below that is the three-dimensional map 25 ascertained by image processor 8. A comparison of the three-dimensional map 21 of the unoccupied vehicle seat with the three-dimensional map 25 of the occupied vehicle seat makes it clear that, using the described image recording device, unequivocal information about the sitting position of a person occupying the vehicle seat can be obtained. The three-dimensional map also gives unequivocal information on whether the seat is occupied in the first place, whether there is a child's seat on it, whether there is a small or a large person on the vehicle seat, or whether the vehicle seat is not occupied at all by a child's seat or a person, but rather, another article has been put down on it.

Abstract] Abstract Of The Disclosure

The device includes a stereoscopic image recording device having at least one optical sensor [(3, 4)] which records the scene at the vehicle seat [(2)] and derives from that a three-dimensional map, partitioned into a plurality of zones, giving for each zone its distance from a reference point. In order to make possible reliable recognition of the manner of the seat's occupation, even during great fluctuations of light intensity, the at least one optical sensor [(3, 4)] has a nonlinear characteristic curve, describing the correlation between the incident light intensity [(L)] and its electrical output signal[(U, I)], whose characteristic curve steepness decreases with increasing light intensity[(L).

(Figures 1, 4)]

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DEVICE FOR DETECTING THE MANNER IN WHICH A VEHICLE SEAT IS OCCUPIED

Background Information

The present invention relates to a device for detecting the manner in which a vehicle seat is occupied, a stereoscopic image recording device having at least one optical sensor recording the scene at the vehicle seat, and deriving from that a three-dimensional map partitioned into a plurality of zones, giving, for each zone, the distance from a reference point.

Investigations, e.g. by NHTBA (National Highway Traffic Safety Administration) have shown that children, sitting in the passenger seat of the vehicle, in particular in a backward aligned child's seat, have suffered deadly injuries from the realease of an airbag. A releasing airbag, in general, poses a danger of injury to a person in the vehicle seat, when this person, for reasons of sitting position, body size or leaning forward in the direction of the airbag prior to the occurrence of the accident, is at too short a distance from the airbag. There are occupational situations, especially in the case of the passenger seat, in which the airbag should better not be released. Among such occupational situations belongs, for example, the occupation of the vehicle seat by a child's seat, or laying down articles not needing protection, or a much too small clearance between the passenger and the airbag. Intelligent airbag systems for use in the future should be in a position to match the amount of airbag inflation to the size and the sitting position of the current vehicle occupant.

That certainly shows that it is unavoidable, for the control of the airbag's release, to detect the manner of occupation of the vehicle seat, in order to avoid unnecessary release of the airbag, or endangering the person in the vehicle seat. There already are different kinds of devices for recognizing the

manner of occupation of the seat. A device for detecting the manner of occupation of a vehicle seat, described in the introduction, which has a stereoscopic image recording system, is known from German Patent 197 41 393 A1. With the use of such a stereoscopic image recording device, distances of the vehicle seat area, divided by zones, form a reference point which can be ascertained with the aid of the known triangulation method. A so-called three-dimensional map containing a plurality of zones is generated thereby, from which can be read with great accuracy whether and how the vehicle seat is occupied, or which sitting position a vehicle passenger sitting on it has assumed for the moment. This information can now be used for controlling restraint systems such as airbags or belt tighteners.

The accuracy of a three-dimensional map created by a image recording device depends strongly on the image-taking quality of the optical sensors. The scenic lighting conditions have a strong influence on the image quality. In motor vehicles, especially, very extreme lighting conditions come about. This is true for one, because the motor vehicle is in an open environment. That means that the most varied lighting conditions are possible - day, night, low-in-the-sky and blinding sun, blinding headlights of other vehicles, etc. Besides that, a vehicle can move very fast, so that lighting conditions can change a great deal in a short space of time (e.g. while driving into a shaded region, while leaving a tunnel and the like. Linear optical sensors, as are used for the recognition of seat occupation according to German Patent 197 41 393 A1, show a very great dependence on changes in brightness of the recorded scene. In order to reduce as far as possible the great brightness dynamics occurring in the vehicle, a strong light source for lighting the scene being looked at is required, according to German Patent 197 41 393 A1.

The present invention now is based on the object of presenting a device, of the kind mentioned at the beginning, which, in spite of the great brightness dynamice, and even without using

a very strong light source, can reliably identify the kind of occupation of a vehicle seat.

Summary of the Invention

The object mentioned is attained by the features of Claim 1, in that the at least one optical sensor, which is contained in the stereoscopic image recording device, has a nonlinear transformer characteristic describing the correlation between the entering light intensity and its electrical output, whose characteristic curve steepness decreases with increasing light intensity. Such a nonlinear optical sensor is capable of recording the scene at the vehicle seat with high resolution, even during great brightness dynamics, only a low-cost light source being required for illuminating the scene.

Advantageous further developments of the present invention come to light from the dependent claims.

Optical sensors whose transducer characteristics have a logarithmic pattern are particularly suitable for recording scenes with very great brightness dynamics.

For the realization of a stereoscopic image recording device, either optical sensors arranged at defined distances from one another can be provided, or a stereooptical instrument, which images two images of the vehicle seat, offset to each other by a defined amount, on a single optical sensor.

Preferably, a light source is available for illuminating the scene of the vehicle seat, which shines synchronously with the activation of the image recording device. It is expedient if the light source shines a light in the infrared region, invisible to the vehicle passengers. In order to keep disturbing scattered light away from the image recording device, an infrared band-pass filter is preferably arranged immediately in front of the at least one optical sensor, whose range lies within the light-sensitive range of the optical sensor.

Brief Description of the Drawing

The present invention is explained in detail below, using several exemplary embodiments represented in the drawing. The figures show:

Figure 1 a vehicle with a stereoscopic image recording device,

Figure 2 a stereoscopic image recording device having two optical sensors,

Figure 3 a stereoscopic image recording device having one optical sensor,

Figure 4 a nonlinear transducer characteristic curve of an optical sensor,

Figure 5a a three-dimensional map of an unoccupied vehicle seat and Figure 5b a three-dimensional map of an occupied vehicle seat.

Description of the Exemplary Embodiments

Figure 1 shows schematically a vehicle 1 having a vehicle seat 2, for example, a passenger seat. In the area of vehicle 1's roof, a stereoscopic image recording device is positioned, containing two optical sensors 3 and 4, by which the scene at vehicle seat 2 is recorded. The two optical sensors 3 and 4 record two image segments, offset by a defined distance from each other, indicated in the drawing by broken borderlines. The two image segments form an overlapping area 5 (the hatched area) which exactly encompasses the space of the vehicle seat in which a person or another object can stay. As can be seen in German Patent 197 41 393 A1, with such a stereoscopic image recording device one can ascertain the distance of image segments from a reference point (e.g. the location of the

optical sensors or the location of the airbag cover), with the aid of known triangulation methods.

The stereoscopic image recording device illustrated in Figure 2, as shown also in Figure 1, includes two optical sensors 3 and 4, arranged at a defined distance from each other. Lenses 6 and 7 are arranged in front of the optical snesors 3 and 4, so as to form suitable rays. The output signals of the two optical sensors 3 and 4 are conducted to an image processor 8, which derives a three-dimensional map of the vehicle seat from the images recorded, as will be explained in more detail in connection with Figures 5a and 5b, and communicates the seat occupation ascertained from this, via an output signal 9, to a control device, not shown, for restraint devices. The control device can then control the release of one or more airbags and belt tighteners, depending on the information 9.

A light source 10 is provided to illuminate the scene at the vehicle seat. The light source 10 has, for example, a plurality of light diodes 11 emitting infrared light. The image processor 8 switches on the light source 10 synchronously with the image sensors 3 and 4. Thus, the light source 10 is only active when the optical sensors 3 and 4 are switched on for taking an image. In that way, the average emitted optical power can be held to as low as possible, at recording time the scene being illuminated with sufficient brightness. Recording of spurious radiation by optical sensors 3 and 4 can be avoided by placing an infrared band-pass filter, adjusted to the spectral range emitted by the light source 10, in front of sensors 3 and 4.

As shown in Figure 3, in place of two optical sensors, one single optical sensor 13 can be put in place, on which, via a stereooptical instrument 2, images are imaged which are offset to each other by a defined amount. The stereooptical instrument has two optical ray paths, having rerouting elements 15, 16 and 17 arranged within them, lenses 18 and 19 being arranged at the input to the stereooptical instrument. The rays taken up by the optical paths, offset to each other,

of the stereooptical instrument, strike adjoining, separate sensor zones in the optical sensor 13. That means, a sensor here records two images, which are evaluated in the image processor 8 exactly the same as in the exemplary embodiment according to Figure 2.

The optical sensors 3, 4, 13 have a transducer characteristic curve shown in Figure 4, which describes the correlation between incident light intensity L and the electrical output signal (voltage U or current I). The transducer characteristic curve has a nonlinear shape such that the characteristic curve steepness decreases with increasing light intensity. An optical sensor with such a nonlinear characteristic curve is known from German Patent (C) 42 09 536 C2. Because of the nonlinear shape of the transducer characteristic curve, the optical sensors 3, 4, 13 convert light signals with great brightness dynamics into a reduced output signal dynamic. Because of that, the contrast of the optical sensors 3, 4, 13 becomes constant, almost independently of the illumination intensity. In the case of such optical sensors, which have a nonlinear, preferably logarithmic transducer characteristic curve, high resolution recording of the scene at the vehicle seat is possible, even at great light intensity fluctuations.

In the upper part of Figure 5a an image segment 20 of vehicle seat 2 is shown, taken by the image recording device. Below that, a three-dimensional map 21, derived by image processor 8 from the two recorded images, is shown. On this map 21, the entire image segment is partitioned into a plurality of zones. The zones are assigned numbers which give the distance of the respective image zone from a reference point. The larger the numerical value, the greater is the distance of the respective image zone from the reference point. Zone 22, for example, has a distance value of 76. Some zones are not furnished with a number because the image processor was not able to ascertain an unequivocal distance value for them.

The upper part of Figure 5b shows an image segment 23 of the vehicle seat 2 occupied by a person 24. Below that is the

three-dimensional map 25 ascertained by image processor 8. A comparison of the three-dimensional map 21 of the unoccupied vehicle seat with the three-dimensional map 25 of the occupied vehicle seat makes it clear that, using the described image recording device, unequivocal information about the sitting position of a person occupying the vehicle seat can be obtained. The three-dimensional map also gives unequivocal information on whether the seat is occupied in the first place, whether there is a child's seat on it, whether there is a small or a large person on the vehicle seat, or whether the vehicle seat is not occupied at all by a child's seat or a person, but rather, another article has been put down on it.

New Claims

1. A device for detecting the manner in which a vehicle seat is occupied, a stereoscopic image recording device having at least one optical sensor (3, 4, 13) recording the scene at the vehicle seat (2), and deriving from it a three-dimensional map (21, 25) partitioned into a plurality of zones, indicating for each zone the distance from a reference point,
wherein the at least one optical sensor (3, 4, 13) has a nonlinear transducer characteristic curve, describing the correlation between the incident light intensity (L) and its electrical output signal (U, I), whose characteristic curve steepness decreases with increasing light intensity (L).

2. The device as recited in Claim 1,
wherein the transducer characteristic curve has a logarithmic shape.

3. The device as recited in Claim 1,
wherein two optical sensors (3, 4), arranged at a defined distance from each other, simultaneously record the scene on the vehicle seat (2).

4. The device as recited in Claim 1,
wherein a stereooptical instrument (14) takes two images of the vehicle seat (2), offset by a defined distance from each other, on a single optical sensor (13).

5. The device as recited in Claim 1,
wherein a light source (10) is present for illuminating the scene on the vehicle seat (2), which shines light synchronously with the activation of the image recording device (3, 4, 13).

6. The device as recited in Claim 5,
wherein the light source (10) shines light in the infrared range.

7. The device as recited in Claims 1, 5 and 6,
wherein an infrared band-pass filter (12) is arranged in front of the at least one optical sensor (3, 4, 13).

Abstract

The device includes a stereoscopic image recording device having at least one optical sensor (3, 4) which records the scene at the vehicle seat (2) and derives from that a three-dimensional map, partitioned into a plurality of zones, giving for each zone its distance from a reference point. In order to make possible reliable recognition of the manner of the seat's occupation, even during great fluctuations of light intensity, the at least one optical sensor (3, 4) has a nonlinear characteristic curve, describing the correlation between the incident light intensity (L) and its electrical output signal (U, I), whose characteristic curve steepness decreases with increasing light intensity (L).

(Figures 1, 4)

Fig. 1

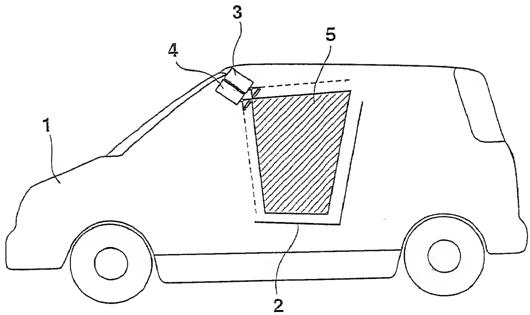


Fig. 4

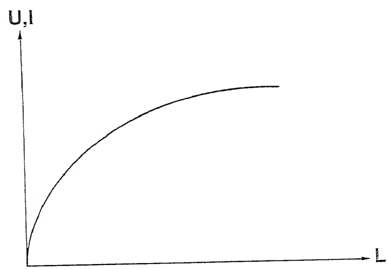


Fig. 2

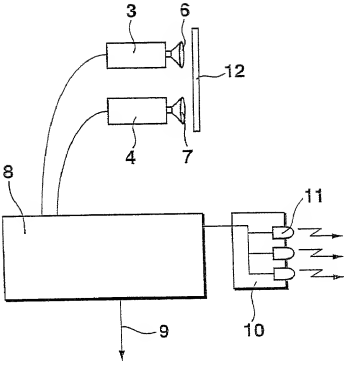


Fig. 3

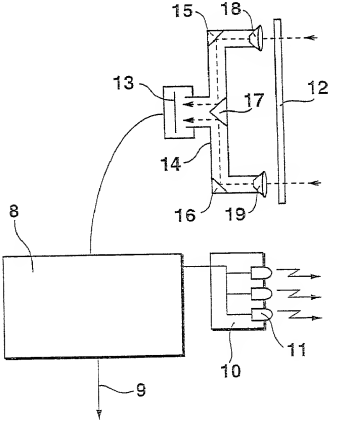
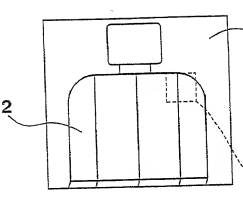


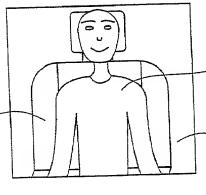
Fig. 5a



		52	52		
	67		63		
	77	75	75	76	110
120	90	85	87		
	97		95		115
107	107	105	104	106	

21

Fig. 5b



		30	31		
	67	32	35		
	77	57	55	57	
120	65	62		62	117
112	72	71	70		115
	85	79	80	106	

25

10191/1782

COMBINED DECLARATION AND
POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below adjacent to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **DEVICE FOR DETECTING THE MANNER IN WHICH A VEHICLE SEAT IS OCCUPIED**, and the specification of which:

[ ] is attached hereto;

[ ] was filed as United States Application Serial No. _____ on _____, ____ and was amended by the Preliminary Amendment filed on _____, ____.

[X] was filed as PCT International Application Number PCT/DE99/03111 the 28th day of September, 1999.

[X] an English translation of which is filed herewith.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a). I hereby claim foreign priority benefits under Title 35, United States Code § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international applications(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the

application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S)
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Country : Germany

Application No. : 198 52 653.9

Date of Filing: November 16, 1998

Priority Claimed
Under 35 U.S.C. § 119 : [X] Yes [ ] No

I hereby claim the benefit under Title 35, United States Code § 120 of any United States Application or PCT International Application designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations § 1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

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U.S. APPLICATIONS

Number :

Filing Date :

PCT APPLICATIONS
DESIGNATING THE U.S.

PCT Number :

PCT Filing Date :

I hereby appoint the following attorney(s) and/or agents to prosecute the above-identified application and transact all business in the Patent and Trademark

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(List name(s) and registration number(s)):

Richard L. Mayer,	Reg. No. 22,490
Gerard A. Messina,	Reg. No. 35,952
_____,	Reg. No. _____
_____,	Reg. No. _____

All correspondence should be sent to:

Richard L. Mayer, Esq.
Kenyon & Kenyon
One Broadway
New York, New York 10004

CUSTOMER NO. 26646

Telephone No.: (212) 425-7200
Facsimile No.: (212) 425-5288

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Full name of inventor Werner POECHMULLER

Inventor's signature X [signature] Date 19 May 2001

Citizenship German

Residence ~~Gutenbergstr. 19~~ Osterbrink 11
31139 Hildesheim DEX
Federal Republic of Germany

Post Office Address Same as above